

Affidavits, Publications and Reports
Dr. Randell L. Mills
BlackLight Power, Inc.
Part 2 of 2

30. N. Popov, "Electrochemical Characterization of BlackLight Power, Inc. MH as Electrodes for Li-ion Batteries, Dept. of Chemical Engineering, University of South Carolina, February 6, 2000.

Electrochemical characterization of MHX (SrHBr, CaHBr, CaHCl, KHBr, and KHI) as electrodes for a Li-ion battery system was carried out in Swagelok three electrode cells (T cells). The anode and the reference electrodes were discs of lithium foil, and the separator was a sheet of Whatman glass fiber filter paper. The cathode consisted of a mixture of the BL/MHX, carbon black and poly(tetrafluoroethylene) which was pressed into a thin film 50-60 mm thick. The electrolyte used was 1 M LiPF₆ in a 1:1:3 mixture of propylene carbonate, ethylene carbonate and dimethyl carbonate (EM Industries). Handling of materials and cell assembling was carried out in an Ar-filled glove box with water content less than 5 ppm (Vacuum Atmospheres). The rest potential of all tested materials was 3.1 V vs. Li/Li⁺ reference electrode. To fingerprint the potentials at which the redox reactions occurred and to determine their electrochemical reversibility, the cyclic voltammograms were obtained for all materials at the potential range from their rest potential in the cathodic direction to 0.5 V vs. Li/Li⁺. Next, the potential was reversed in the anodic direction to 3.5 V and 4.2 V vs. Li/Li⁺ reference electrode. The scan rate was 0.1 mV/s for all cases. A cathodic peak was observed in the cyclic voltammogram of CaHBr, CaHCl, and KHI indicating reduction of the electrode active material. CaHBr and CaHCl could be cycled. CaHBr, CaHCl, and KHI have potential as primary batteries. CaHBr also shows promise as an electrode active material for a secondary battery.

31. Technology Insights, 6540 Lusk Boulevard, Suite C-102, San Diego, CA 92121, "HydroCatalysis Technical Assessment Prepared for PacifiCorp", August 2, 1996.

This report documents a technical assessment of a novel source of hydrogen energy advanced by HydroCatalysis Power Corporation now BlackLight Power, Inc. (BLP). The assessment was conducted as part of the due diligence performed for PacifiCorp. It was conducted by a literature search and review, site visits to BLP and collaborating organizations, and telephone interviews with others active in the general

area. A description of concept is provided in Section 3. Section 4 presents an assessment of the concept background, supporting theory, laboratory prototypes, projected initial products, and economic and environmental aspects. Section 5 documents the results of telephone interviews and site visits. An overall summary and conclusions are presented in the following section.

32. Kline-Anderson, Inc., 8926 Kirby Drive, Houston, TX 77054, "Review of Schedule and Resource Requirements to Develop a HydroCatalysis Functional Prototype Unit Final Report for Technology Insights", October 23, 1996.

This report documents a technical assessment of a novel source of hydrogen energy advanced by HydroCatalysis Power Corporation now BlackLight Power, Inc. (BLP). The report is based on fact finding trips to BLP and NovaTech and written documentation provided by BLP and Technology Insights. The assessment was conducted as part of the due diligence performed for PacifiCorp under guidance of Technology Insights. The work scope was to assess and formulate a plan to commercial the BLP technology by a new commercialization company COMCO with a considerable investment by PacifiCorp. Plans for development of a functional prototype unit and comments and recommendations regarding planned tasks, resource requirements, and project schedule are given.

33. P. M. Jansson, "HydroCatalysis: A New Energy Paradigm for the 21st Century", Thesis Submitted in partial fulfillment of the requirements of the Masters of Science in Engineering Degree in the Graduate Division of Rowan University, May 1997, Thesis Advisors: Dr. J. L. Schmalzel, Dr. T. R. Chandrupatla, and Dr. A. J. Marchese, External Advisors: Dr. J. Phillips, Pennsylvania State University, Dr. R. L. Mills, BlackLight Power, Inc., W. R. Good, BlackLight Power, Inc.

This thesis reviews the problems of worldwide energy supply, describes the current technologies that meet the energy needs of our industrial societies, summarizes the environmental impacts of those fuels and technologies and their increased use by a growing global and increasing technical economy. The work also describes and advances the technology being developed by BlackLight Power, Inc. (BLP) a scientific company located in Princeton, New Jersey. BLP's technology proports to offer commercially viable and useful heat generation via a previously unrecognized natural phenomenon - the catalytic reduction of the hydrogen atom to a

lower energy state. Laboratory tests obtained as original research of this thesis as well as the review of the data of others substantiate the fact that replication of the experimental conditions which are favorable to initiating and sustaining the new energy release process will generate controllable, reproducible, sustainable and commercial meaningful heat. For example, Jansson has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. Approximately 10^{-3} moles of hydrogen was admitted to a 20 cm^3 Calvet cell containing a heated platinum filament and KNO_3 powder. In the three separate trials with a platinum filament hydrogen dissociator which was varied in length of 10 cm, 20 cm, and 30 cm, a mean power of 0.581, 0.818, and 1.572 watts was observed, receptively. The closed experiments were run to completion. The energy observed was 622, 369, and 747 kJ, respectively, This is equivalent to the generation of $6.2 \times 10^5 \text{ J/mole}$, $3.7 \times 10^5 \text{ J/mole}$, and $7.5 \times 10^5 \text{ J/mole}$ of hydrogen, respectively, as compared to $2.5 \times 10^5 \text{ J/mole}$ of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be at least 1000 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model. Convincing evidence is presented to lead to the conclusion that BLP technology has tremendous potential to achieve commercialization and become an energy paradigm for the next century. The research was also conducted as part of the due diligence performed for Atlantic Energy now Conectiv.

34. Phillips, J., Smith, J., Kurtz, S., "Report On Calorimetric Investigations Of Gas-Phase Catalyzed Hydrino Formation" Final report for Period October-December 1996", January 1, 1997, A Confidential Report submitted to BlackLight Power, Inc. provided by BlackLight Power, Inc., Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.

Pennsylvania State University Chemical Engineering Department has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. In three separate trials, between 10 and 20 K Joules were generated at a rate of 0.5 Watts, upon admission of approximately 10^{-3} moles of hydrogen to the 20 cm^3 Calvet cell containing a heated platinum filament and KNO_3 powder. This is equivalent to the generation of 10^7 J/mole of hydrogen, as compared to $2.5 \times 10^5 \text{ J/mole}$ of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be 100 times too

large to be explained by conventional chemistry, but the results are completely consistent with Mills model.

35. Phillips, J., Shim, H., "Additional Calorimetric Examples of Anomalous Heat from Physical Mixtures of K/Carbon and Pd/Carbon", January 1, 1996, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of ionic hydrogen spillover catalytic material: 40% by weight potassium nitrate (KNO_3) on graphitic carbon powder with 5% by weight 1%-Pd-on-graphitic carbon (K^+/K^+ electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst. However, no excess power was observed with flowing helium over the catalyst mixture. Rates of heat production were reproducibly observed which were higher than that expected from the conversion of all the hydrogen entering the cell to water, and the total energy observed was over four times larger than that expected if all the catalytic material in the cell were converted to the lowest energy state by "known" chemical reactions. Thus, "anomalous" heat, heat of a magnitude and duration which could not be explained by conventional chemistry, was reproducibly observed.

36. Bradford, M. C., Phillips, J., "A Calorimetric Investigation of the Reaction of Hydrogen with Sample PSU #1", September 11, 1994, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of nickel oxide powder containing strontium niobium oxide ($\text{Nb}^{3+}/\text{Sr}^{2+}$ electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst which increased with increasing flow rate. However, no excess power was observed with flowing helium over the catalyst/nickel oxide mixture or flowing hydrogen over nickel oxide alone. Approximately 10 cc of

nickel oxide powder containing strontium niobium oxide immediately produced 0.55 W of steady state output power at 523 μ K. When the gas was switched from hydrogen to helium, the power immediately dropped. The switch back to hydrogen restored the excess power output which continued to increase until the hydrogen source cylinder emptied at about the 40,000 second time point. With no hydrogen flow the output power fell to zero.

The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers: $n = 1/2, 1/3, 1/4, \dots$. Transitions to these lower energy states are stimulated in the presence of pairs of niobium and strontium ions ($\text{Nb}^{3+}/\text{Sr}^{2+}$ electrocatalytic couple) which provide 27.2 eV energy sinks.

37. Jacox, M. G., Watts, K. D., "The Search for Excess Heat in the Mills Electrolytic Cell", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, January 7, 1993.

Idaho National Engineering Laboratory (INEL) operated a cell identical to that of Thermacore [16] except that it was minus the central cathode and that the cell was wrapped in a one-inch layer of urethane foam insulation about the cylindrical surface. The cell was operated in a pulsed power mode. A current of 10 amperes was passed through the cell for 0.2 seconds followed by 0.8 seconds of zero current for the current cycle. The cell voltage was about 2.4 volts, for an average input power of 4.8 W. The electrolysis power average was 1.84 W, and the stirrer power was measured to be 0.3 W. Thus, the total average net input power was 2.14 W. The cell was operated at various resistance heater settings, and the temperature difference between the cell and the ambient as well as the heater power were measured. The results of the excess power as a function of cell temperature with the cell operating in the pulsed power mode at 1 Hz with a cell voltage of 2.4 volts, a peak current of 10 amperes, and a duty cycle of 20 % showed that the excess power is temperature dependent for pulsed power operation, and the maximum excess power was 18 W for an input electrolysis joule heating power of 2.14 W. Thus, the ratio of excess power to input electrolysis joule heating power was 850 %. INEL scientists constructed an electrolytic cell comprising a nickel cathode, a platinized titanium anode, and a 0.57 M K_2CO_3 electrolyte. The cell design appears in Appendix 1. The cell was operated in the environmental chamber in the INEL Battery Test Laboratory at constant current,

and the heat was removed by forced air convection in two cases. In the first case, the air was circulated by the environmental chamber circulatory system alone. In the second case, an additional forced air fan was directed onto the cell. The cell was equipped with a water condenser, and the water addition to the cell due to electrolysis losses was measured. The data of the forced convection heat loss calorimetry experiments during the electrolysis of a 0.57 M K_2CO_3 electrolyte with the INEL cell showed that 13 W of excess power was produced. This excess power could not be attributed to recombination of the hydrogen and oxygen as indicated by the equivalence of the calculated and measured water balance.

38. Peterson, S., H., Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC, 1310 Beulah Road, Pittsburgh, PA, February 25, 1994.

Westinghouse Electric Corporation reports that excess heat was observed during the electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) where the electrolysis of aqueous sodium carbonate served as the control. The data of the temperature of the cell minus the ambient temperature shows that when potassium carbonate replaced sodium carbonate in the same cell with the same input electrolysis power, the potassium experiment was twice as hot as the sodium carbonate experiment for the duration of the experiment, one month. The net faraday efficiency of gas evolution was experimentally measured to be unity by weighing the experiment to determine that the expected rate of water consumption was observed. The output power exceeded the total input power. The data was analyzed by HydroCatalysis Power Corporation [29].

39. Mills, R., Analysis by HydroCatalysis Power Corporation of Westinghouse Report Entitled "Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC", February 25, 1994.

The data from the Westinghouse Report [28] was analyzed by HydroCatalysis Power Corporation now BlackLight Power, Inc. Westinghouse scientists report that excess heat was observed during the electrolysis of aqueous potassium carbonate (K^+/K^+ catalysts); whereas, no excess heat was observed during the electrolysis of aqueous sodium carbonate. The data of the temperature of the cell minus the ambient temperature showed that when potassium carbonate replaced sodium carbonate in the same cell with the same input electrolysis power, the potassium

experiment was twice as hot as the sodium carbonate experiment for the duration of the experiment, one month. The present experimental results are consistent with the release of heat energy from hydrogen atoms where pairs of potassium ions (K^+/K^+ electrocatalytic couple) induce the electrons of hydrogen atoms to relax to quantized energy levels below that of the "ground state" by providing a net enthalpy equal to an integer multiple of 27.2 eV which stimulate these transitions. Excess heat was observed only when Na_2CO_3 was replaced by K_2CO_3 . For two sodium ions, no comparable reaction with a net enthalpy equal to an integer multiple of is possible. The excess energy could not be explained by recombination or known chemistry.

40. **Haldeman, C. W., Savoye, G. W., Iseler, G. W., Clark, H. R., MIT Lincoln Laboratories Excess Energy Cell Final report ACC Project 174 (3), April 25, 1995.**

During the electrolysis of aqueous potassium carbonate, researchers working at MIT Lincoln Laboratories observed long duration excess power of 1-5 watts with output/input ratios over 10 in some cases with respect to the cell input power reduced by the enthalpy of the generated gas. In these cases, the output was 1.5 to 4 times the integrated volt-ampere power input. Faraday efficiency was measured volumetrically by direct water displacement.

41. **Craw-Ivanco, M. T.; Tremblay, R. P.; Boniface, H. A.; Hilborn, J. W.; "Calorimetry for a Ni/K_2CO_3 Cell", Atomic Energy Canada Limited, Chemical Engineering Branch, Chalk River Laboratories, Chalk River, Ontario, June 1994.**

Atomic Energy Canada Limited, Chalk River Laboratories, report that 128 % and 138% excess heat were observed in separate experiments by flow calorimetry during the electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) in a closed cell, and that 138% was observed in an open cell.

42. **Shaubach, R. M., Gernert, N. J., "Anomalous Heat From Hydrogen in Contact with Potassium Carbonate", Thermacore Report, March 1994.**

A high temperature/high pressure/high power density industrial prototype gas cell power generator which produced 50 watts of power at $300\text{ }^\circ\text{C}$ having a nickel surface area of only 300 cm^2 was successfully developed. A sample of the nickel tubing of the aqueous potassium carbonate permeation cell was analyzed by XPS at the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University. A

broad peak centered at 54.6 eV was present; whereas, the control nickel tube showed no feature. The binding energy (in vacuum) of $H(n = 1/2)$ is 54.4 eV. Thus, the theoretical and measured binding energies for $H(n = 1/2)$ are in excellent agreement. No excess energy or 54.6 eV feature were observed when sodium carbonate replaced potassium carbonate.

43. Gernert, N., Shaubach, R. M., Mills, R., Good, W., "Nascent Hydrogen: An Energy Source," Final Report prepared by Thermacore, Inc., for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Contract Number F33615-93-C-2326, May, (1994).

In a report prepared for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Thermacore reports, "anomalous heat was observed from a reaction of atomic hydrogen in contact with potassium carbonate on a nickel surface. The nickel surface consisted of 500 feet of 0.0625 inch diameter tubing wrapped in a coil. The coil was inserted into a pressure vessel containing a light water solution of potassium carbonate. The tubing and solution were heated to a steady state temperature of 249 °C using an I^2R heater. Hydrogen at 1100 psig was applied to the inside of the tubing. After the application of hydrogen, a 32 °C increase in temperature of the cell was measured which corresponds to 25 watts of heat. Heat production under these conditions is predicted by the theory of Mills where a new species of hydrogen is produced that has a lower energy state than normal hydrogen. ESCA analysis, done independently by Lehigh University, have found the predicted 55 eV signature of this new species of hydrogen."

44. Wiesmann, H., Brookhaven National Laboratory, Department of Applied Science, Letter to Dr. Walter Polansky of the Department of Energy Regarding Excess Energy Verification at Brookhaven National Laboratory, October 16, 1991.

Calorimetry of continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cell by Noninski at Brookhaven National Laboratory. Dr. Weismann observed the experiment and reported the results to Dr. Walter Polansky of the U. S. Department of Energy. Dr. Weismann reports, "The claim is as follows. The temperature rise in the dewar is greater in the case of electrolysis as compared to

using a resistor, even though the power dissipated is equal in both cases. According to Dr. Mills' theory, this apparent "excess power" is due to the fact that the electron in a hydrogen atom can "decay" to stable subinterger quantum levels. **Dr. Noninski demonstrated this thermal effect at BNL.**" The observed rise in temperature for a given input power was twice as high comparing electrolysis versus heater power.

45. Nesterov, S. B., Kryukov, A. P., Moscow Power Engineering Institute Affidavit, February, 26,1993.

The Moscow Power Engineering Institute experiments showed 0.75 watts of heat output with only 0.3 watts of total power input (power=VI) during the electrolysis of an aqueous potassium carbonate electrolyte with a nickel foil cathode and a platinized titanium anode. Excess power over the total input on the order of 0.45 watts was produced reliably and continuously over a period of three months. Evaluation of the electrolyte after three months of operation showed no significant change in its density or molar concentration. The cell was disassembled and inspected after over one month of operation at 0.1 amperes. This inspection showed no visible signs of a reaction between the electrodes and the electrolyte. The cell was re-assembled and operated as before. Excess energy was produced for the three month duration of the experiment. Scintillation counter measurements showed no signs of radiation external to the cell.

46. Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University Bethlehem, PA, November 1993.

Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS by Miller and Simmons of the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University. A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of $H(n = 1/2)$ is 54.4 eV. Thus, the theoretical and measured binding energies for $H(n = 1/2)$ are in excellent agreement. Lehigh University has conducted an extensive investigation of the cathodes from heat producing as well as those from control cells. Miller concludes that "I was unable to find any other elements on the surface that cause the feature. The persistent appearance of a spectral feature near the predicted binding energy for many of the electrodes used with a K electrolyte is an encouraging piece of evidence for the existence of the reduced energy state hydrogen".

47. **Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [36] were confirmed at Idaho National Engineering Laboratory (INEL). Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates [38]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [39]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

48. **Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [36] were confirmed at Idaho National Engineering Laboratory (INEL) [37]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [39]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

49. **Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [36] were confirmed at Idaho National

Engineering Laboratory (INEL) [37]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates [38]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

50. Gary L. Turner, Ph.D., Rule 132 Declaration; Bala Dhandapani, Ph.D., Rule 132 Declaration.

Dr. Turner has been conducting NMR scans for over 20 years. He conducted scans on about 100 blind samples of compounds provided by BlackLight Power, Inc. Dr. Turner observed signals at -4 to -5 ppm. Dr. Turner states that he has never before observed signals in this range.

Dr. Dhandapani is a research scientist at BlackLight Power, Inc. His declaration identifies the samples sent to Dr. Turner NMR analysis. Dr. Dhandapani states that the upfield shifts to -4 to -5 ppm demonstrates the existence of lower energy states in which the electron is closer to the nucleus in the hydrogen atoms of the compounds.

51. Jonathan Phillips, Ph.D., Rule 132 Declaration.

Dr. Phillips conducted an experiment using an electrolytic cell and a potassium catalyst according to Dr. Mills invention. Dr. Phillips observed an excess of heat that could not be explained by any conventional chemical process.